

SECTION 517

POST-TENSIONING

517.01. DESCRIPTION.

Post-tensioning work consists of prestressing cast-in-place concrete by furnishing, placing, and tensioning of prestressing steel in accordance with details shown in the contract documents and as specified in these specifications.

This work shall include the furnishing and installation of any appurtenant items necessary for the particular prestressing system to be used, including but not limited to ducts, anchorage assemblies and grout used for pressure grouting ducts.

517.02. MATERIALS.

- (a) **Concrete.** Use Class P concrete meeting the requirements of Section 509.
- (b) **Reinforcing Steel.** Use reinforcing steel meeting the requirements of Section 511.
- (c) **Prestressing Steel.** Use prestressing steel of the type specified in the contract documents and meeting the requirements of the following Subsections as applicable for the type:

Strands for Prestressing	723.04
Bars for Post-tensioning	723.05
Parallel Wire Assemblies for Post-tensioning	723.06

Assign a lot number to all wire, strand, or bars shipped to the project site and tag for identification purposes. Each lot of wire or bars and each reel of strand reinforcement shall be accompanied by a manufacturer's certificate of compliance, a mill certificate, and a test report. The mill certificate and test report shall include:

- the chemical composition (not required for strand),
- cross-sectional area,
- elongation at rupture,
- modulus of elasticity, and
- the stress-strain curve for actual prestressing steel intended for use.

All values certified shall be based on test values and nominal cross-sectional areas of the material being certified.

- (d) **Corrosion Inhibitor.** Corrosion inhibitor for prestressing steel shall consist of a vapor phase inhibitor (VPI) powder conforming to the provisions of Federal Specification MIL-P-3420F-87 or as otherwise approved.
- (e) **Grout.** In making grout for pressure grouting the post-tensioning ducts, use materials conforming to the following requirements:
 - 1. *Portland Cement.* Portland Cement shall conform to one of the following:
Specifications for Portland Cement - AASHTO M 85, Type I, II, or III.

Cement used for grouting shall be fresh and shall not contain any lumps or other indication of hydration or "pack set."

2. *Water.* The water used in the grout shall conform to the requirements of Subsection 701.04.
3. *Admixtures.* Admixtures, if used, shall impart the properties of low-water content, good flowability, minimum bleed, and expansion if desired. They shall contain no chemicals in quantities that may have harmful effect on the prestressing steel or cement. Do not use admixtures that, at the dosage used, contain chlorides in excess of 0.005% of the density of the cement used or contain any fluorides, sulphites, and nitrates.

When a grout expanding admixture is required, or is used at the Contractor's option, it shall be well dispersed through the other admixtures and shall produce a 2 to 6% unrestrained expansion of the grout. Determine by tests the amount of admixture needed to obtain a desired amount of expansion. If the source of manufacture or brand of either the admixture or cement changes after testing, conduct new tests to determine proper proportions.

Use all admixtures in accordance with the manufacturers' instructions.

- (f) **Ducts.** Ducts used to provide holes or voids in the concrete for the placement of post-tensioned tendons may be either formed with removable cores or may consist of rigid or semi-rigid ducts that are cast into the concrete.

When using removable cores to form ducts, form the ducts with no constrictions that would block the passage of grout. Remove all coring materials.

Ducts formed by sheath left in place shall be a type that will not permit the intrusion of cement paste. They shall transfer bond stresses as required and retain shape under the weight of the concrete and shall have sufficient strength to maintain their correct alignment without visible wobble during placement of concrete.

1. *Metal ducts.* Sheathing for ducts shall be metal, except as otherwise specified in the contract documents. Such ducts shall be galvanized ferrous metal and shall be fabricated with either welded or interlocked seams. Galvanizing of welded seams will not be required. Rigid ducts shall have smooth inner walls and shall be capable of being curved to the proper configuration without crimping or flattening. Semi-rigid ducts shall be corrugated and, when the tendons are to be inserted after the concrete has been placed, their minimum wall thickness shall be 26 gage (0.45 mm) for ducts less than or equal to $2\frac{5}{8}$ inch (67 mm) diameter and 24 gage (0.60 mm) for ducts greater than $2\frac{5}{8}$ inch (67 mm) diameter. When bar tendons are preassembled with such ducts, the duct thickness shall not be less than 31 gage (0.25 mm).
2. *Polyethylene Ducts.* As an alternative to metal ducts, ducts for transverse tendons in deck slabs and at other locations shown on the contract drawings, may be made of high density polyethylene conforming to material requirements of ASTM D 3350.

Do not use polyethylene ducts when the radius or curvature of the tendon is less than 30 feet (9.1 m).

Semi-rigid polyethylene ducts for use where completely embedded in concrete shall be corrugated with minimum material thickness of 0.050 inch (1.25 mm) \pm 0.010 inch (0.25 mm). Such ducts shall have a white coating on the outside, or shall be of white material with ultraviolet stabilizers added.

Rigid polyethylene ducts for use where the tendon is not embedded in concrete shall be rigid pipe manufactured in accordance with ASTM D2447, ASTM F714, ASTM D2239, or AASHTO T 85. For external applications, such ducts shall have an external diameter to wall thickness ratio of 21 or less.

For applications where a polyethylene duct is exposed to sunlight or ultraviolet light, carbon black shall be incorporated into the polyethylene pipe resin in such amount to provide resistance to ultraviolet degradation in accordance with ASTM D 1248.

3. *Size of Ducts.* The inside diameter of ducts shall be at least $\frac{1}{4}$ inch (6 mm) larger than the nominal diameter of single bar or strand tendons. For multiple bar or strand tendons, the inside cross-sectional area of the duct shall be at least 2.0 times the net area of the prestressing steel, except, where the tendons are to be placed by the pull-through method, the duct area shall be at least 2.5 times the net area of the prestressing steel.

The size of ducts shall not exceed 0.4 times the least gross concrete thickness at the duct.

4. *Duct Fittings.* Couplings and transition fittings for ducts formed by sheathing shall be of either ferrous metal or polyethylene, and shall be cement paste intrusion proof and sufficient strength to prevent distortion or displacement of the ducts during concrete placement.

Provide all ducts or anchorage assemblies with pipes or other suitable connections at each end of the duct for the injection of grout after prestressing. Provide ducts with ports for venting or grouting at the high points and for draining at intermediate low points.

Vent and drain pipes shall be $\frac{1}{2}$ inch (12 mm) minimum diameter standard pipe or suitable plastic pipe. Connections to ducts shall be made with metallic or plastic structural fasteners. The vents and drains shall be mortar tight, taped as necessary, and shall provide means for injection of grout through the vents and for sealing to prevent leakage of grout.

- (g) **Post-tensioning Anchorages and Couplers.** Comply with Subsection 723.07 and the following.

All anchorages and couplers shall develop at least 96% of the actual ultimate strength of the prestressing steel, when tested in an unbonded state, without exceeding anticipated set. The coupling of tendons shall not reduce the elongation at rupture below the requirements of the tendon itself. Couplers and coupler components shall be enclosed in housings long enough to permit the necessary movements. Couplers for tendons shall be used only at locations specifically indicated in the contract documents or approved by the Engineer. Couplers shall not be used at points of sharp tendon curvature.

1. *Bonded Systems.* Bond transfer lengths between anchorages and the zone where full prestressing force is required under service and ultimate loads shall normally be sufficient to develop the minimum specified ultimate strength of the prestressing steel. When anchorages or couplers are located at critical section under ultimate load, the ultimate strength required of the bonded tendons shall not exceed the ultimate capacity of the tendon assembly, including the anchorage or coupler, tested in an unbonded state.

Use housings designed so that complete grouting of all coupler components will be accomplished during grouting of tendons.

Refer to the following subsection, *Unbonded Systems*, for dynamic testing requirements for bonded systems.

2. *Unbonded Systems.* For unbonded tendons, perform two dynamic tests on a representative anchorage and coupler specimen. In the first test, the tendon shall withstand, without failure, 500,000 cycles from 60% to 66% of its minimum specified ultimate strength, and, in the second test, 50 cycles from 40% to 80% of its minimum specified ultimate strength. Take each cycle to be the change from lower stress level to the upper stress level and back to the lower. Different specimens may be used for each of the two tests. Systems utilizing multiple strands, wires, or bars may be tested utilizing a test tendon of smaller capacity than the full-size tendon.

Dynamic tests shall be required on bonded tendons where the anchorage is located or used in such manner that repeated load applications can be expected on the anchorage.

When dynamic testing is required, perform the testing and furnish certified copies of test results that indicate conformance with the specified requirements before installation of anchorages or couplers.

Anchorages for unbonded tendons shall not cause a reduction in the total elongation under ultimate load of the tendon to less than 2% measured in a minimum gauge length of 10 feet (3m) .

Protect all the coupling components completely with a coating material before encasement in concrete.

3. *Anchorage Device Acceptance Test.* Use anchorage devices tested by the following test procedure and meeting the requirements specified.
 - 3.1 *Test Block Requirements.* Provide a rectangular prism test block containing those anchorage components that will also be embedded in the concrete of the post-tensioned structure. Comply with the practical application and anchor supplier specifications in arranging the anchorage components. Place in the test block an empty duct of a size appropriate for the maximum tendon size that can be accommodated by the anchorage device.
 - 3.2 *Test Block Dimensions.* Make the dimensions of the test block perpendicular to the tendon in each direction:
 - $1.1F_{pu}$ for specimens tested under cyclic or sustained loading,
 - $1.2F_{pu}$ for specimens tested under monotonic loading.
 The maximum crack width shall not exceed:
 - 0.010 inch (0.12 mm) at $0.8F_{pu}$ after the completion of cyclic or sustained loading, or at $0.9F_{pu}$ after the completion of the one hour monotonic loading period.
 - 0.016 inch (0.20 mm) at $0.9F_{pu}$ for cyclic or sustained loading, or at $1.0F_{pu}$ for monotonic loading.
 - 3.8 *Test Series Requirements.* Test three specimens to make a test series. Each test in the series shall meet the anchorage zone requirements. If one of the three specimens fails to meet these requirements, a supplementary test of three additional specimens is allowed.
 - 3.9 *Records of the Anchorage Device.* Record the following information for each anchorage device acceptance test:
 - Dimensions of the test specimens,

- Drawings and dimensions of the anchorage device, including all confining reinforcing steel,
- Amount and arrangement of supplementary skin reinforcement,
- Type and yield strength of reinforcing steel,
- Type and compressive strength at time of testing of concrete,
- Type of testing procedure and all measurements specified for the procedure.

517.03. EQUIPMENT.

- (a) **Jacking Equipment.** For stressing the tendons, furnish hydraulic jacks that can provide and sustain the necessary forces and are equipped with a gauge, either a pressure gauge or a load cell, for determining the jacking stress. Use a jacking system that provides an independent means of measuring tendon elongation.

Equip the jack with a gauge that can be read within 1% of the final jacking force. The gauge shall be either a dial at least 6 inches (150 mm) in diameter or a digital display. The range of a load cell shall be such that the lower 10% of the manufacturer's rated capacity will not be used to measure stress. Calibrate each jack and its gauge as a unit with the cylinder extension in the approximate position that it will be at final jacking force. Provide a certified calibration chart or curve with each jack and gauge combination. Recalibrate the gauges at least once a year and whenever gauge pressures and elongations indicate materially different stresses.

Use a jack capable of slow release of stress to allow relaxation from overstress to the proper seating force.

- (b) **Grouting Equipment.** Furnish grouting equipment that includes a mixer capable of continuous mechanical mixing that will produce a grout free of lumps and undispersed cement, a grout pump of sufficient capacity to properly place grout in quantities and pressures required, and standby flushing equipment with water supply.

Accessory equipment that will provide for accurate solid and liquid measures shall be provided to batch all materials.

The pump shall be a positive displacement type and be able to produce an outlet pressure gauge reading of at least 150 psi (1.0 MPa). The pump shall have seals adequate to prevent introduction of oil, air or other foreign substance into the grout and to prevent loss of grout or water.

A pressure gauge having a full scale reading of no greater than 300 psi (2 MPa) shall be placed at some point in the grout line between the pump outlet and the duct inlet. Standby flushing equipment capable of developing a pumping pressure of 250 psi (1.7 MPa) and of sufficient capacity to flush out with water any partially grouted ducts shall be provided.

The grouting equipment shall contain a screen having clear openings of $\frac{1}{8}$ inch (3 mm) maximum size to screen the grout before its introduction into the grout pump. If a grout with a thixotropic additive is used, a screen opening of $\frac{3}{16}$ inch (4.75 mm) will be satisfactory. This screen shall be easily accessible for inspection and cleaning.

The grouting equipment shall utilize gravity feed to the pump inlet from a hopper attached to and directly over it. The hopper shall be kept at least partially full of grout at all times during the pumping operation to prevent air from being drawn into the post-tensioning duct.

Under normal conditions, the grouting equipment shall be capable of continuously grouting the largest tendon on the project in no more than 20 minutes.

Grout pipes and vents shall be fitted with positive mechanical shutoff valves capable of withstanding the pumping pressures. These valves shall not be removed or opened until the grout has set. Leakage of grout through the anchorage assembly shall be prevented by positive mechanical means.

517.04. CONSTRUCTION METHODS.

- (a) **General.** Conform to the applicable requirements of Sections 502, 504, 509 and 511 and the following requirements.

When the design for the prestressing work is not fully detailed in the contract documents, determine the details or type of prestressing system for use and select materials and details conforming to these specifications as needed to satisfy the prestressing requirements. The system selected shall provide the magnitude and distribution of prestressing force and ultimate strength required by the contract documents without exceeding allowable temporary stresses. Unless otherwise shown in the contract documents, all design procedures, coefficients and allowable stresses, friction and prestress losses, as well as tendon spacing and clearances, shall be in accordance with the *AASHTO Standard Specifications for Highway Bridges* and the *Guide Specifications for Design and Construction of Segmental Concrete Bridges*, as applicable.

When the effective working force or stress is specified in the contract documents, consider it to be the force or stress remaining in the prestressing steel after all losses, including creep and shrinkage of concrete, elastic shortening of concrete, relaxation of steel, friction and take up or seating of anchorages, and all other losses peculiar to the method or system of prestressing have taken place or have been provided for. When the jacking force is specified in the contract documents, consider it to be the force applied to the tendon before anchorage and the occurrence of any losses, including the anchor set loss.

- (b) **Working Drawings.** When the contract documents do not include complete details for a prestressing system and its method of installation, or when proposing any change in these items, submit working drawings of the prestressing system proposed for use. Comply with Subsection 105.03. Submit falsework drawings with prestressing drawings.

Show in the working drawings complete details and substantiating calculations of the method, materials, and equipment proposed for use in the prestressing including any additions or rearrangement of reinforcing steel and any revision in concrete dimensions from that specified in the contract documents. Outline the method and sequence of stressing and complete specifications and details of the prestressing steel and anchorage devices, working stresses,

anchoring stresses, tendon elongations, type of ducts, and all other data pertaining to the prestressing operation, including the proposed arrangement of the prestressing steel in the members.

Show on these drawings details of type, size, and number of strands, bars, wires per duct, anchorage devices, duct profiles, grouting and venting ports, marking used to identify unlike ducts and their location, total force per duct with proper conversion to the units expressed on the jack gauge, total elongation, temporary overstress and other information necessary to properly complete the work.

Include a complete numbered layout showing the steel and step-by-step stressing sequence on the drawings. Include details of prestressing steel slack removal, overstress, gauge reading for seating, elongation measurement and wedge seating.

Also include the details of the method of support for and dimensions to properly locate the ducts so steel will be at its proper location. List and describe the pressure grouting materials and equipment including backup equipment.

(c) **Ducts.**

1. *Placement.* Rigidly support ducts at the proper locations in the forms by ties to reinforcing steel. Use ties that are adequate to prevent displacement during concrete placement. Use supplementary support bars where needed to maintain proper alignment of the duct. Use hold-down ties to the forms when the buoyancy of the ducts in the fluid concrete would lift the ducts. Maintain a tolerance $\pm 1/4$ inch (6 mm) for duct position.

Couple joints between sections of duct with positive connections that do not result in angle changes at the joints and will prevent the intrusion of cement paste.

After placing ducts and completing reinforcement and forming, inspect the ducts to locate possible damage. Repair all unintentional holes or openings in the duct before placing concrete.

Secure grout openings and vents to the duct and to either the forms or to reinforcing steel to prevent displacement during concrete placing operations. Cover the ends of ducts to prevent the entry of water or debris.

2. *Vents and Drains.* For continuous structures, vent all ducts at high points of the duct profile, except where the curvature is small, as in continuous slabs, and at additional locations as specified in the contract documents. Where freezing conditions can be anticipated before grouting, install drains at low points in ducts where needed to prevent the accumulation of water. Leave low-point drains open until grouting is started.

Remove the end of vents and drains 1 inch below the surface of the concrete after grouting has been completed, and fill the void with mortar. Comply with Subsection 509.04(h).

(d) **Prestressing Steel.**

1. *Packaging, Storing and Handling.* Protect all prestressing steel against physical damage and rust or other results of corrosion at all times from manufacture to grouting. Prestressing steel that has sustained physical damage at any time shall be rejected. The development of pitting or other results of corrosion, other than rust stain, shall be cause for rejection.

Keep prestressing steel packaged in containers or shipping forms for the protection of the steel against physical damage and corrosion during shipping and storage. Place a corrosion inhibitor in the package or form, or when permitted, apply directly to the steel. Use a corrosion inhibitor meeting these specifications and having no deleterious effects on steel, concrete, or grout, or the bond strength between each of these. Repair or replace damaged packaging or forms.

Clearly mark the shipping package or form with a statement that the package contains high strength prestressing and the type of corrosion inhibitor used, including the date packaged.

2. *Placement.* Before installing prestressing steel in the ducts, demonstrate that the ducts are free of water and debris immediately before installing the prestressing steel. Pull the total number of strands in an individual tendon through the duct as a unit, or pull or push individual strands through the duct.

If prestressing steel is preinstalled in the ducts before concrete placement, accurately place the assembly of prestressing steel and ducts and hold in position while placing concrete.

Set and hold anchorage devices or block-out templates for anchorages so that their axis coincides with the axis of the tendon and anchor plates are normal in all directions to the tendon.

Distribute the prestressed steel so that the force in each girder stem is equal or as required by the contract documents. For box girders with more than two girder stems, the prestressing force may vary up to 5% from the theoretical required force per girder stem provided the required total force in the superstructure is obtained and the force is distributed symmetrically about the centerline of the typical section.

3. *Protection of Steel after Installation.* Continuously protect prestressing steel against rust or other corrosion by using a corrosion inhibitor placed in the ducts or directly applied to the steel, unless the prestressed steel is grouted within 10 days after installation in the duct.

After placing tendons in ducts, seal the ends of the ducts to prevent entry of moisture.

When steam curing is used, do not install prestressing steel until steam curing is completed.

Whenever electric welding on or near member containing prestressing steel, directly attach the ground to the steel being welded. Protect prestressing steel and hardware from weld spatter or other damage.

- (e) **Anchorage Hardware.** Properly place all anchorage materials according to the approved working drawings and the requirements of the anchorage device supplier. Exercise care and attention in placing anchorage hardware, reinforcement, concrete, and consolidation of concrete in anchorage zones. Do not modify the local zone details without approval.

Maintain a tolerance of $\pm 1/4$ inch (6 mm) for the position of tendon anchorage bearing plates.

- (f) **Tensioning.**

1. *General.* Tension prestressing steel using approved jacking equipment to produce the forces shown in the contract documents or on the approved working drawings, with appropriate allowance for all losses. Determine losses in accordance with the AASHTO “*Standard Specifications for Highway Bridges*” and include the anchor set loss appropriate for the

anchorage system employed. Limit stressing values, both before and after seating, to the values permitted by AASHTO.

Before post-tensioning any member, demonstrate to the satisfaction of the Engineer that the prestressing steel is free and unbonded in the duct.

During stressing of strand, individual wire failures may be accepted if not more than one wire in any strand is broken and the area of broken wires does not exceed 2% of the total area of the prestressing steel in the duct.

2. *Concrete Strength and Age Requirements.* Apply prestressing forces only after all concrete in the member to be post-tensioned has attained the specified strength for initial stressing and has aged at least 10 days.
3. *Sequence of Stressing.* When the sequence of stressing individual tendon is not otherwise specified in the contract documents or on the approved working drawings, stress tendons in a sequence that produce a minimum of eccentric force in the member.

Stress simultaneously all strand in each tendon with a multiple strand jack. Stress tendons from both ends unless otherwise specified in the contract documents or in the approved working drawings.

4. *Measurement of Stress.* Provide a record of gauge pressures and tendon elongations for each tendon for approval. Measure elongation to an accuracy of $\frac{1}{16}$ inch (1.5 mm). Do not cut off stressing tails until the stressing records have been approved.

Determine the stress in tendons during tensioning by gauge or load cell readings and verify with measured elongations. For the calculations of anticipated elongations, utilize the nominal area and modulus of elasticity as furnished by the manufacturer for the lot of steel being tensioned, or as determined by a bench test of strands used in the work.

Tension all tendons to a preliminary force as necessary to eliminate any take-up in the tensioning system before starting elongation readings. Make this preliminary force between 5% and 25% of the final jacking force. Measure the initial force using a dynamometer or other approved method, so that its amount can be used as a check against elongation as computed and as measured. Mark each strand before final stressing to permit measurement of elongation and insure that all anchor wedges set properly.

It is anticipated that there may be a possible difference in indicated stress between jack pressure and elongation of about 5%. In such event, the error shall be so placed that the discrepancy shall be on the side of a slight overstress rather than understress. In the event of an apparent discrepancy between gauge pressure and elongation of more than 5% in tendons over 50 feet (15 m) long and 7% in tendons 50 feet (15 m) or less in length, carefully check the entire operation and determine the source of error before proceeding further.

(g) **Grouting.**

1. *General.* Permanently protect and bond prestressing steel to the concrete by completely filling the void space between the duct and the tendon with grout.
2. *Preparation of Ducts.* Clean all ducts of deleterious materials that would impair bonding of the grout or interfere with grouting.

Flush ducts with clean, potable water. The water may contain slack lime (calcium hydroxide) or quicklime (calcium oxide) in the amount of 1.7 pounds per gallon (0.2 kg per liter) . After flushing, blow out all water in the duct with oil-free compressed air.

3. *Mixing of Grout.* Add water to the mixer first, followed by the Portland Cement and admixture, or as required by the admixture manufacturer.

Mix long enough to obtain a uniform, thoroughly blended grout, without excessive temperature increase or loss of expansive properties of the admixture. Continuously agitate the grout until it is pumped.

Do not add water to increase grout flowability that has decreased by delayed use of the grout.

Determine proportions of materials based on tests made on the grout before grouting is begun, based on prior documented experience with similar materials and equipment and under comparable field conditions (weather, temperature, etc.). Use the minimum amount of water in the grout mixture as is necessary for proper placement. When Type I or II cement is used, limit the water cement ratio to a maximum of 0.45.

Determine the pumpability of grout in accordance with the U. S. Corps of Engineers Method CRD-C79. When this method is used, the efflux time of the grout sample immediately after mixing shall not be less than 11 seconds. The flow cone test does not apply to grout which incorporates a thixotropic additive.

4. *Injection of Grout.* Open all grout and highpoint vent openings when starting to grout. Pump the grout through the duct and continuously waste at the outlet until no visible slugs of water or air are ejected and the efflux time of ejected grout, as measured by a flow cone test, if used, is not less than that of the injected grout. Allow grout to flow from the first vent after the inlet pipe until any residual flushing water or entrapped air has been removed, and then cap or otherwise close the vent. Close the remaining vents in sequence in the same manner.

To ensure that the tendon remains filled with grout, close the outlet and allow the pumping pressure to be raised to not less than 70 psi (0.5 MPa) and held for at least 15 seconds. Close the valve at the inlet while maintaining this pressure. Do not remove plugs, caps, or valves until the grout has set.

Limit the pumping pressure at the tendon inlet to a maximum of 250 psi (1.7 MPa) . If the actual grouting pressure exceeds the maximum recommended pumping pressure, inject the grout at any vent that has been, or is ready to be capped as long as a one way flow of the grout is maintained. If this method is used, fit the vent to be used for injection with a positive shutoff. When one-way flow of the grout cannot be maintained, immediately flush out the duct with clean, potable water.

5. *Temperature and Grout Strength.* When temperatures are below 32°F (0°C) , keep ducts free of water to avoid damage due to freezing.

Maintain the temperature of the concrete above 35°F (2°C) from the time of grouting until the job site cured 2 inch cubes of grout reach a minimum required compressive strength of 800 psi (5.5 MPa) .

Limit the temperature of the grout to a maximum of 90°F (32°C) during mixing and pumping. If necessary, cool the grout mixing water.

517.05. METHOD OF MEASUREMENT.

Post-tensioning (*prestressing*) will be measured by the lump sum. The concrete for post-tensioned cast-in-place concrete structures will be measured under Section 509. The reinforcing steel for post-tensioned cast-in-place concrete structures will be measured under Section 511.

517.06. BASIS OF PAYMENT.

The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay item listed below if shown in the bid schedule. Payment will be full compensation for the work prescribed in this Section. Payment will be made under:

(A) PRESTRESSING LUMP SUM

SECTION 520

STRUCTURAL CONCRETE REPAIR BY SEALING AND INJECTION

520.01. DESCRIPTION.

This work shall consist of structurally rebonding cracks, delaminations and hollow planes in Portland cement concrete structures and restoring the structural integrity of the concrete by injecting and sealing the cracks in the structure with an epoxy resin system as shown on the contract documents or as directed by the Engineer.

520.02. MATERIALS.

- (a) **Injection Ports.** Injection ports shall be tubes, fittings, pressure plates or other suitable devices to serve as an entry port for accepting the epoxy resin system under injection pressures of 60 psi (0.4 MPa). Provide suitable means for sealing each port after completing injection of the port.
- (b) **Crack Sealer.** Provide a sealing compound as recommended by the epoxy resin manufacturer that is suitable for sealing cracks in concrete members and anchoring the injection ports during the injection and curing of the epoxy resin system.
- (c) **Pressure Plates.** Pressure plates may be used instead of sealing compound. The pressure plates must be made of clear plastic and shall be cut to appropriate lengths, widths and shapes to cover the cracks adequately.
- (d) **Epoxy Resin System.** The epoxy resin system shall be a non-shrink, 100% solid, two-component, moisture-insensitive material formulated for pressure injection. The mixed epoxy system shall meet the requirements in Table 520-1.